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# The Changing Role of the Country Grain Elevator in Ohio, 1970-1979

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# The Changing Role of the Country Grain Elevator in Ohio, 1970-1979

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## INTRODUCTION

Country elevators supply farmers with needed inputs and related services. They also serve as a point of first assembly for grain sold off the farm. Consequently, when farmers change their output mix or their method of marketing grain, the mix of inputs and services country elevators provide farmers should also change.

Between 1970 and 1980, Ohio farmers changed both their output mix and their method of marketing grain. Specifically, the number of cattle, hogs, and sheep and lambs marketed decreased by 20, 22, and 45%, respectively (5). In contrast, production of corn, soybeans, and wheat increased by 90, 97, and 87%, respectively (5). Furthermore, the share of grain Ohio farmers sold direct to processing firms and terminal elevators increased (3).

## OBJECTIVES

Given the above, the mix of inputs and services provided by Ohio country elevators should have changed during the 1970's. Examination of the extent and analysis of the importance of these changes formed the basis for this study. Specifically, its objectives were:

- To describe changes during the 1970's in the business activities of a sample of Ohio country elevators.
- To examine the implications of these changes for the future of the Ohio country elevator industry.

## DATA

Since changes during the 1970's were being studied, data covering this period were needed. These were obtained by resurveying the country elevators which had participated in a 1971 survey of Ohio grain handling firms. Taken together, these two surveys permitted a case study of those country elevators which had taken part in both surveys.

All elevators and grain processing firms located in Ohio must be licensed by the Grain Warehouse Division, Ohio Dept. of Agriculture. Consequently, their list was used as the universe for the 1971 sample. This sample included all elevators listed as having 500,000 or more bushels of storage capacity, all feed manufacturers who produced and marketed a "brand name" feed, all soybean processors, and all flour millers and blenders. Also included, through random sampling, were 20% of those elevators listed as having between 100,000 and 499,999 bushels of storage capacity and 10% of those elevators listed as having less than 100,000 bushels of storage capacity.

Data were collected for the calendar year 1970 through personal interviews with each firm's general manager or accountant. The data collected included grain received by source, grain shipped by destination, storage capacity, and degree of involvement in various business activities. Usable surveys were obtained from 90 grain handling firms.[3]

To identify the country elevators among these 90 firms, the following definition was used:

> A country elevator is a firm, either independent, cooperative, or line, primarily engaged in buying and selling grain, retailing agricultural inputs, and/or providing related services for farmers. It receives more than 50% of its grain from farmers and earns less than 50% of its income from manufacturing feed or feed ingredients.[4]

Given this definition, 59 of the grain handling firms qualified as country elevators. Because the 1971 survey had sampled larger elevators at a higher rate than smaller elevators, a disproportionate number of the country elevators included in the case study were from the larger size categories. This bias should be kept in mind when evaluating the results presented below.

The 59 country elevators were resurveyed in 1980. This survey contained only the questions of interest from the 1971 survey: storage capacity, total volume of grain received and shipped, and degree of involvement in various business activities.[5] Furthermore, to insure comparability, each question was worded exactly as in 1971. Lastly, the data collected were for calendar year 1979.

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[3]For a more complete discussion of the 1971 survey, see Baldwin and Sharp (1, pp. 3 and 5).

[4]This definition is a combination of those used by Westerhold (6, p. 9), Baldwin and Sharp (1, p. 5), and Hennen, **et al.** (3, p. 36), modified to include the restriction on feed manufacturing.

[5]A copy of the 1980 survey is included in Appendix A.

## DESCRIPTIONS OF THE SURVEYED OHIO COUNTRY GRAIN ELEVATORS, 1970 AND 1979

Usable returns were obtained from 49 of the 59 country elevators surveyed in 1980. These 49 elevators formed the data base for this case study. Almost all of them were located in western Ohio, the main cash grain production area in Ohio (Fig. 1). Twenty-nine were owned by cooperatives while 20 were privately held.

Of the 10 country elevators not included in the case study, five had gone out of business. This figure translates into an 8.5% failure rate for the 1970-1979 period. However, ownership changes had occurred at nine of the country elevators included in the case study. Since some of these ownership changes most likely occurred because of financial problems, the above failure rate probably understates the financial stress experienced by Ohio country elevators during the survey period.

### Grain Handling Sources of Income

For the 49 country elevators which formed the case study, both average storage capacity and average volume of grain received increased from 1970 to 1979. The former increased from 677.2 to 990.7 thousand bushels while the latter increased from 1.4 to 2.3 million bushels. These increases represent a continuation of the historical trends (4).

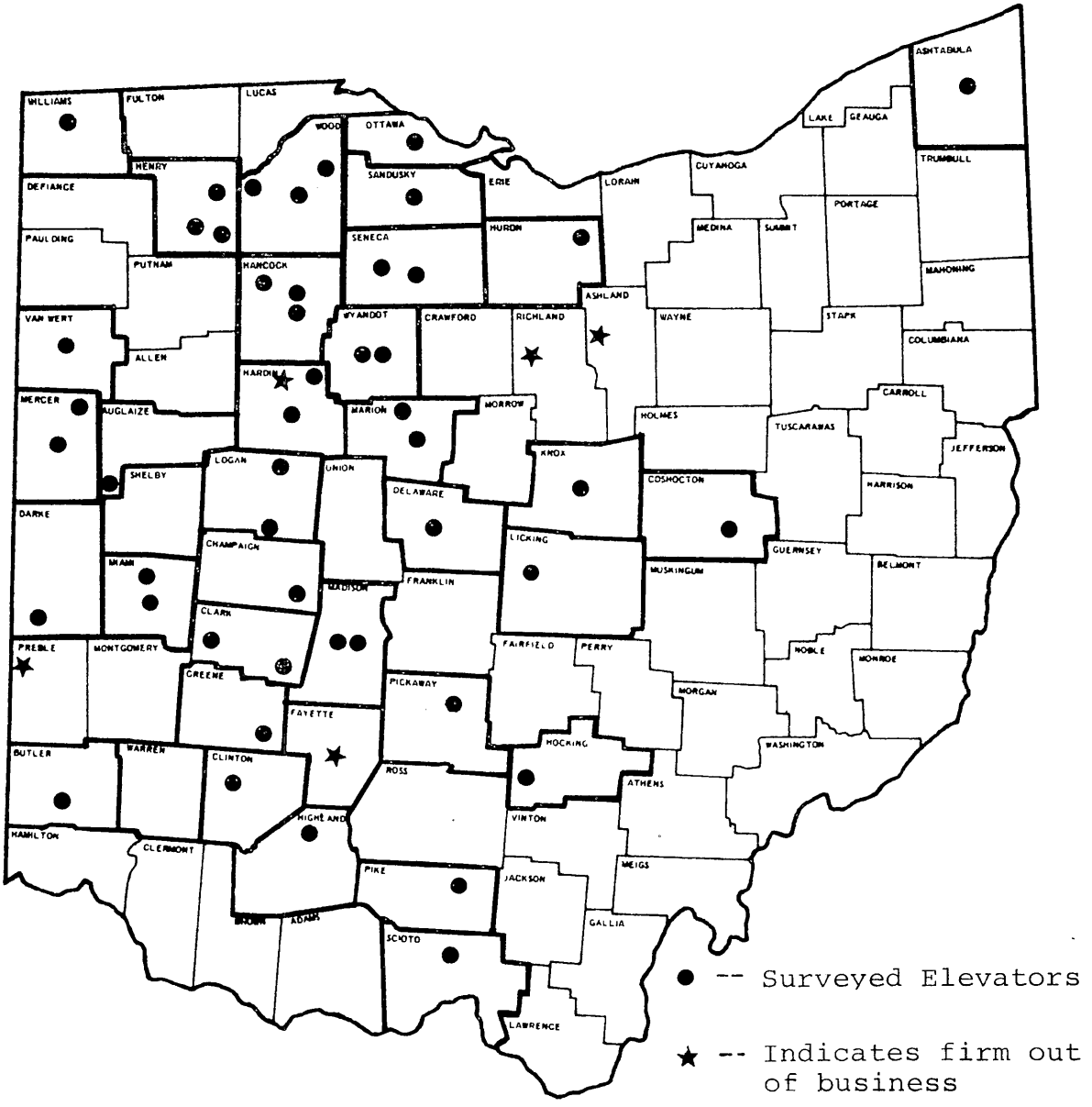


**FIG. 1.—Locations of sampled country elevators, Ohio, 1971 and 1980.**

**TABLE 1.—Percent of Total Gross Income Earned from Grain Merchandising, Country Elevators, Ohio, 1970 and 1979.**

| Percent of Total Gross Income | 1970 | 1979 |
|---|---|---|
| | Percent of Firms* | |
| 0 - 30 | 27 | 45 |
| 31 - 50 | 24 | 14 |
| 51 - 72 | 24 | 12 |
| 73 - 100 | 24 | 29 |
| Total† | 100 | 100 |

*Based on 49 observations.
†Total may not add to 100 due to rounding.
Source: Survey data.

**TABLE 2.—Percent of Total Gross Income Earned from Storing Grain, Country Elevators, Ohio, 1970 and 1979.**

| Percent of Total Gross Income | 1970 | 1979 |
|---|---|---|
| | Percent of Firms* | |
| 0 | 14 | 20 |
| 1 - 4 | 33 | 29 |
| 5 - 9 | 24 | 10 |
| 10 - 35 | 29 | 41 |
| Total | 100 | 100 |

*Based on 49 observations.
Source: Survey data.

**TABLE 3.—Percent of Total Gross Income Earned from Drying Grain, Country Elevators, Ohio, 1970 and 1979.**

| Percent of Total Gross Income | 1970 | 1979 |
|---|---|---|
| | Percent of Firms* | |
| 0 | 25 | 37 |
| 1 - 4 | 41 | 16 |
| 5 - 9 | 18 | 22 |
| 10 - 30 | 16 | 25 |
| Total | 100 | 100 |

*Based on 49 observations.
Source: Survey data.

Despite the increase in average physical volume of grain received, average percent of total gross income received from grain merchandising declined from 52% in 1970 to 45% in 1979. None of the surveyed country elevators had ceased merchandising grain by 1979, but the smallest proportion of total gross income earned from this activity had decreased from 8% in 1970 to 1% in 1979.

Note that the decline in average percent of total gross income derived from grain merchandising was a relative, not an absolute, decline. The larger average volume of grain received in 1979 compared with that of 1970 implies an absolute increase in average gross income from grain merchandising.

Distribution of the surveyed firms by percent of total gross income earned from grain merchandising had a bimodal distribution in 1979 compared with that of 1970 (Table 1). A large increase in the smallest category combined with a small increase in the largest category to create the bimodal distribution. Thus, during the 1970's, a substantial number of the surveyed country elevators had reduced their dependence on grain merchandising. On the other hand, there was little indication of a decline in the dependence on grain merchandising for those sampled country elevators earning more than 72% of their gross income from grain merchandising.

Five of the country elevators surveyed in 1970 had installed unit train facilities by 1979. Somewhat surprisingly, on average, their share of gross income from grain merchandising had declined more than that of the other country elevators surveyed. In 1970, the five elevators received an average 65% of their gross income from this activity. The range was 33 to 90%. By 1979, the average had declined to 40% and the range was 8 to 89%.

Associated with grain merchandising are the services of storing and drying grain. Between 1970 and 1979, the percent of surveyed country elevators engaged in these activities declined (Tables 2 and 3). However, for both services, the percent of surveyed country elevators in the largest category increased. The net result was an increase in average percent of total gross income earned from both storing and drying grain. The former increased from 7 to 8% between 1970 and 1979 while the latter increased from 4 to 6% over this survey period.

The increase in share of gross income from storing and drying grain partly offset the decline in share of gross income from grain merchandising. A net 4% decline remained. This decline probably reflects the increase in direct farmer marketing to processors and terminals.

### Non-Grain Handling Sources of Income

Besides handling grain, country elevators have traditionally manufactured and/or sold complete feeds, manufactured and/or sold feed ingredients, and sold farm production inputs other than feed. Each of these activities is discussed in this section.

For the surveyed country elevators, the manufacturing and/or selling of complete feeds increased during the 1970's while the manufacturing and/or selling of feed ingredients declined. Percent of total gross income from manufacturing and/or selling complete feeds averaged 3% in 1970. The range was 0 to 22%. By 1979, the average had increased to 10%

**TABLE 4.—Percent of Total Gross Income Earned from Manufacturing Complete Feeds, Country Elevators, Ohio, 1970 and 1979.**

| Percent of Total Gross Income | 1970 | 1979 |
|---|---|---|
| | Percent of Firms* | |
| 0 | 78 | 33 |
| 1 - 10 | 4 | 39 |
| 11 - 16 | 14 | 10 |
| 17 - 64 | 4 | 18 |
| Total | 100 | 100 |

*Based on 49 observations.
Source: Survey data.

**TABLE 5.—Percent of Total Gross Income Earned from Manufacturing Feed Ingredients, Country Elevators, Ohio, 1970 and 1979.**

| Percent of Total Gross Income | 1970 | 1979 |
|---|---|---|
| | Percent of Firms* | |
| 0 | 45 | 77 |
| 1 - 10 | 25 | 23 |
| 11 - 16 | 8 | 2 |
| 17 - 40 | 22 | 4 |
| Total | 100 | 100 |

*Based on 49 observations.
Source: Survey data.

**TABLE 6.—Percent of Total Gross Income Earned from Fertilizer Sales, Country Elevators, Ohio, 1970 and 1979.**

| Percent of Total Gross Income | 1970 | 1979 |
|---|---|---|
| | Percent of Firms* | |
| 0 - 2 | 22 | 24 |
| 3 - 7 | 27 | 12 |
| 8 - 10 | 24 | 16 |
| 11 - 38 | 27 | 47 |
| Total† | 100 | 100 |

*Based on 49 observations.
†Total may not add to 100 due to rounding.
Source: Survey data.

**TABLE 7.—Percent of Total Gross Income Earned from Retailing Farm Production Inputs Excluding Fertilizer and Feed, Country Elevators, Ohio, 1970 and 1979.**

| Percent of Total Gross Income | 1970 | 1979 |
|---|---|---|
| | Percent of Firms* | |
| 0 | 51 | 22 |
| 1 - 10 | 22 | 45 |
| 11 - 30 | 18 | 18 |
| 31 - 53 | 8 | 14 |
| Total† | 100 | 100 |

*Based on 49 observations.
†Total may not add to 100 due to rounding.
Source: Survey data.

and the range had become 0 to 64% (Table 4). Another indicator of growth, percent of surveyed firms involved in the activity, increased from 27 to 67%. In contrast, the percent of surveyed firms engaged in manufacturing and/or selling feed ingredients declined from 53 to 22% (Table 5). Reflecting this decline, average percent of total gross income earned from this activity decreased from 8% in 1970 to 2% in 1979.

Adding the two feed-related activities together, the average percent of total gross income remained fairly constant. It was 11% in 1970 and 12% in 1979. This stability was surprising given the large decline in livestock production in Ohio. It suggests that the surveyed country elevators remained competitive in the feed supply sector. However, problems could arise if the decline in livestock numbers continues.

The changing mix in feed-related activities can be attributed to the increasing specialization of livestock farming. Many livestock farmers do not raise enough grain to meet their feeding needs; thus, they must buy grain as well as feed ingredients. By buying complete feeds rather than the individual ingredients, shipping costs are reduced. In addition, the buying of complete feeds requires less management/coordination time than the buying and mixing of the individual feed ingredients.

A second major source of non-grain handling income has been the retailing of farm production inputs. Since the selling of complete feeds and feed ingredients was combined with the manufacturing of these items, the following discussion involves non-feed farm production inputs. It is divided initially into two parts. One examines only fertilizer sales because of fertilizer's importance as a crop input. The second examines sales of non-feed, non-fertilizer farm production inputs.

More than three-fourths of the surveyed country elevators sold fertilizer in both 1970 and 1979 (Table 6). However, the 1979 distribution was bimodal compared with the 1970 distribution. As a group, the surveyed country elevators moved from the two middle categories to the highest one. Meanwhile, percent of firms in the smallest category stayed fairly constant. Thus, the average percent of total gross income earned from fertilizer sales increased, going from 9 to 12%.

Percent of total gross income earned from selling non-fertilizer, non-feed farm production inputs also increased. The average went from 8% in 1970 to 13% in 1979. In addition, the percent of surveyed firms engaged in this activity increased from 49 to 78% (Table 7).

Combining the above two activities, average per-

cent of total gross income earned from selling non-feed farm production inputs increased from 17% in 1970 to 25% in 1979, an increase of 47%. Thus, the surveyed country elevators substantially increased their selling of non-feed farm production inputs. This increase reflects the substantial increase in crop production in Ohio during the 1970's and the increasing importance of purchased inputs in crop production.

Non-grain handling business activities not discussed above were grouped into a miscellaneous category. The most prominent of these activities were the selling of coal, lumber, and clothing. In 1970, 76% of the surveyed elevators earned more than 1% of their total gross income from miscellaneous activities. In 1979, the figure was 33%. Correspondingly, the average share of total gross income earned from miscellaneous activities decreased from 9 to 4%. Thus, during the 1970's the sampled Ohio country elevators had concentrated their business activities on production agriculture related inputs and services.

### Summary of Changes from 1970 to 1979

The changes described above indicate a restructuring of the business activities of the surveyed Ohio country elevators during the 1970's. In particular, the share of gross income from grain merchandising declined while the share from selling non-feed farm production inputs increased. To further examine the importance of the changes described in the preceding sections, they were projected into the future. Results of these projections are presented in the next section.

## PROJECTION OF CHANGES WHICH OCCURRED FROM 1970 TO 1979

This section addresses the question, what would be the structure of the business activities of the sampled Ohio country elevators if the changes observed from 1970 to 1979 were to continue. The technique chosen to make these projections was the Markov process. It was selected because it projects a distribution of firms over the variable or activity being analyzed. Thus, it conveys more information than other projection techniques, which project only an average value for the variable or activity. However, like all projection techniques, the Markov process projections are valid only as long as changes in the sampled country elevators' environment continue at the same rate as those observed during the base period. Any deviation from the observed rates would cause the business structure of the surveyed country elevators to deviate from that predicted.

To forecast a variable or activity using the Markov process, the observed values for the variable or activity must be divided into categories. Thus, each country elevator is placed in a category according to its value for the variable or activity. Consequently, the probabilities that a sampled country elevator remained in the same category or moved from one category to another between 1970 and 1979 can be calculated. These probabilities are then used to project the distribution of the sampled country elevators over the variable or activity.[6]

The variables and/or activities chosen for projection were volume of grain received and percent of total gross income earned from merchandising grain, supplying feed, selling farm production inputs excluding feed, and providing services. Each of these projections is discussed below.

The Markov process projected a continued increase in the volume of grain received. Thus, the absolute value of gross income from grain merchandising should increase. However, on average, the relative share of total gross income earned from grain merchandising was forecast to continue its decline. Nevertheless, at equilibrium, 33% of the sampled country elevators were projected to earn more than 50% of their gross income from grain merchandising (Table 8). Furthermore, little change was predicted in the percent of the sampled country elevators earning more than 72% of their total gross income from this activity. This result suggests that those sampled country elevators heavily dependent on grain merchandising as a source of gross income in 1979 will likely remain heavily dependent on this source in the future.

Feed supply activities were defined to include the manufacturing and/or selling of complete feeds and/or feed ingredients. A small decline was projected for average percent of total gross income earned from these activities. The projection also revealed that a majority of the sampled country elevators would earn

[6]For a more complete discussion of the Markov process, see Appendix B.

**TABLE 8.—Distribution of Country Elevators by Percent of Total Gross Income Earned from Grain Merchandising, Ohio, 1970, 1979, and Estimated Equilibrium.**

| Percent of Total Gross Income | 1970 | 1979 | Equilibrium |
|---|---|---|---|
| | Percent of Firms* | | |
| 0 - 30 | 27 | 45 | 54 |
| 31 - 50 | 24 | 14 | 13 |
| 51 - 72 | 24 | 12 | 8 |
| 73 - 100 | 24 | 29 | 25 |
| Total† | 100 | 100 | 100 |

*Based on 49 observations.
†Total may not add to 100 due to rounding.
Source: Survey data.

between 1 and 10% of their total gross income from feed supply activities at the estimated equilibrium. Percent of elevators in this category increased 12 percentage points between 1979 and the estimated equilibrium (Table 9). In contrast, percent of elevators in the other categories declined over this period. The projected homogenization probably reflects the effects of increasing specialization in livestock production and declining livestock numbers.

**TABLE 9.—Distribution of Country Elevators by Percent of Total Gross Income Earned from Feed Supply Activities, Ohio, 1970, 1979, and Estimated Equilibrium.***

| Percent of Total Gross Income | 1970 | 1979 | Equilibrium |
|---|---|---|---|
| | | Percent of Firms† | |
| 0 | 27 | 22 | 16 |
| 1 - 10 | 24 | 41 | 53 |
| 11 - 16 | 20 | 20 | 18 |
| 17 - 64 | 29 | 16 | 12 |
| Total‡ | 100 | 100 | 100 |

*Feed supply activities included the manufacturing and/or selling of complete feeds and/or feed ingredients.
†Based on 49 observations.
‡Total may not add to 100 due to rounding.
Source: Survey data.

**TABLE 10.—Distribution of Country Elevators by Percent of Total Gross Income Earned from Selling Farm Production Inputs Excluding Feed, Ohio, 1970, 1979, and Estimated Equilibrium.**

| Percent of Total Gross Income | 1970 | 1979 | Equilibrium |
|---|---|---|---|
| | | Percent of Firms* | |
| 0 - 3 | 27 | 16 | 4 |
| 4 - 12 | 24 | 18 | 18 |
| 13 - 24 | 24 | 16 | 22 |
| 25 - 66 | 24 | 49 | 55 |
| Total† | 100 | 100 | 100 |

*Based on 49 observations.
†Total may not add to 100 due to rounding.
Source: Survey data.

**TABLE 11.—Distribution of Country Elevators by Percent of Total Gross Income Earned from Providing Services for Farmers, Ohio, 1970, 1979, and Estimated Equilibrium.***

| Percent of Total Gross Income | 1970 | 1979 | Equilibrium |
|---|---|---|---|
| | | Percent of Firms† | |
| 0 - 2 | 27 | 29 | 31 |
| 3 - 6 | 24 | 18 | 16 |
| 7 - 15 | 24 | 16 | 13 |
| 16 - 65 | 24 | 37 | 40 |
| Total‡ | 100 | 100 | 100 |

*Services included the drying and storing of grain as well as feed grinding and custom application of chemicals and fertilizers if these latter activities were identified in the **Other** category on the survey instrument.
*Based on 49 observations.
‡Total may not add to 100 due to rounding.
Source: Survey data.

For the Markov process projection of the retailing of non-feed farm production inputs, percent of total gross income earned from fertilizer sales was combined with percent of total gross income earned from selling other farm production inputs excluding feed. During the base period, percent of total gross income received from selling these inputs increased substantially. The Markov process revealed that a major long-term component of this increase was a decline in the percent of sampled elevators earning less than 3% of their total gross income from selling non-feed farm production inputs (Table 10). By equilibrium, only 4% of the firms remained in this category compared with 16% in 1979. In addition, the percent of sampled country elevators in the two largest categories increased 12 percentage points. Taken together, these two changes suggest a continued, steady increase in the percent of total gross income earned from selling non-feed farm production inputs. This projected increase reflects the growing importance of crop production in Ohio and the increasing importance of purchased inputs in crop production.

Unlike the projections for the above discussed activities, the Markov process projection of percent of total gross income earned from providing farm production services forecast only minor changes from the 1979 distribution (Table 11). This result suggests that gross income derived from farm production services may stabilize as a percent of total gross income. Services included drying and storing grain as well as feed grinding and custom application of chemicals and fertilizers if these later two activities were identified in the *Other* category on the survey instrument.

To summarize the above Markov process projections, volume of grain received is forecast to increase. Nevertheless, grain merchandising, on average, is forecast to continue its decline as a source of gross income. However, for a substantial number of the sampled country elevators, it will remain the dominant source of gross income. The feed manufacturing projection forecast that the majority of sampled country elevators would earn between 1 and 10% of their total gross income from this activity. Percent of total gross income earned from selling non-feed farm production inputs is projected to increase as more of the sampled country elevators engage in this activity and/or increase their involvement. Lastly, gross income from providing farm production services is predicted to remain a reasonably constant percent of total gross income.

## SUMMARY AND CONCLUSIONS

This case study of 49 Ohio country elevators provides evidence that the Ohio country elevator industry altered its mix of business activities during the 1970's. The changes corresponded with those suggested by the statewide increase in crop production and by the increase in direct farmer marketing of grain to processors and terminals.

Specifically, the study found that volume of grain received by the sampled Ohio country elevators increased between 1970 and 1979. The Markov process projected a continuation of this increase. Nevertheless, on average, percent of total gross income earned from grain merchandising declined between 1970 and 1979 and was forecast to continue to decline. However, for those sampled country elevators earning more than 72% of their total gross income from grain merchandising in 1979, little decline in their dependence on this source of income was indicated by the Markov process projections.

During the 1970's, part of the decline in the average share of total gross income from grain merchandising was offset by an increase in the average share received from storing and drying grain. A net decline of 4% occurred. This net decline could increase in the future since the Markov process revealed little expected growth in the share of total gross income derived from service activities, such as the storing and drying of grain.

The study also found that the mix of feed-related activities at the sampled elevators changed between 1970 and 1979. Average share of total gross income from manufacturing and/or selling complete feeds increased from 3 to 10%. In contrast, average share of total gross income from manufacturing and/or selling feed ingredients decreased by 6 percentage points to 2% of total gross income in 1979. This shift in feed activities was probably due to the increasing specialization in livestock production. Overall, the share of total gross income from feed-related activities changed very little. This stability was surprising given the large decline in livestock production in Ohio.

The Markov process forecast of the share of total gross income from feed-related activities revealed that an increasing number of the sampled country elevators should earn between 1 and 10% of their total gross income from these activities. The forecast also suggested a small decline in average percent of total gross income from feed-related activities. However, the decline could be larger if the downward trend in livestock numbers accelerates or if on-farm mixing of feed increases.

Lastly, the share of total gross income from selling non-feed farm production inputs increased from 17 to 25% of total gross income between 1970 and 1979. This trend was projected to continue. It reflects the increasing importance of crop production in Ohio and the increasing use of purchased inputs in crop production.

In conclusion, since country elevators form a service industry for production agriculture, their business activities must change to meet changes in the needs of the farm production sector. This case study suggests that, during the 1970's, Ohio's country elevators as a group adjusted their business activities to reflect the growing importance of crop production in Ohio's agriculture and the increase in direct farmer marketing of grain to processors and terminals. However, Ohio's country elevators must continue to make adjustments even if the underlying trends in the needs of Ohio's production agriculture do not change. Failure to make these adjustments could place them in a precarious financial situation. Especially vulnerable to this possible outcome are those Ohio country elevators which are heavily dependent on grain merchandising as a source of gross income.

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## APPENDIX A

## 1980 OHIO ELEVATOR SURVEY INSTRUMENT

Firm Name _____

Address _____

Business Phone _____

Manager _____

1. What percent of your 1979 gross income came from (major sources of income only):

| | | Percent of Gross |
|---|---|---|
| a. | Grain Merchandising | _____ |
| b. | Storing Grain for Farmers or CCC | _____ |
| c. | Drying Grain for Farmers | _____ |
| d. | Manufacturing and/or Selling Complete Feed | _____ |
| e. | Manufacturing and/or Selling Feed Ingredients | _____ |
| f. | Processing Soybeans | _____ |
| g. | Processing Corn | _____ |
| h. | Processing Wheat or Other Grains | _____ |
| i. | Retailing Farm Supplies | _____ |
| j. | Fertilizer Sales | _____ |
| k. | Other (list)_____ | _____ |

2. What was the **total** amount of grain and feed storage space of your facility as of July 1, 1979, in bushels of shelled corn equivalent for grain and in tons for feed?

| | Grain | Feed |
|---|---|---|
| Total | _____Bu | _____Tons |

3. How many bushels of the following grains did you receive in the past year?

| | |
|---|---|
| Corn | _____Bu |
| Wheat | _____Bu |
| Soybeans | _____Bu |
| Oats | _____Bu |

4. How many bushels of the following grains did you ship in the past year?

| | |
|---|---|
| Corn | _____Bu |
| Wheat | _____Bu |
| Soybeans | _____Bu |
| Oats | _____Bu |

## APPENDIX B
## DESCRIPTION OF MARKOV PROCESS

To forecast changes in a variable or activity using the Markov process, the observed values of the variable or activity must first be divided into categories. Consequently, each firm is placed in a category according to its value for the variable or activity. For the 2 years for which data are collected, an individual firm may be in the same category or in different categories. Combining all the sampled firms allows calculation of the probabilities that an individual firm remained in a given category or moved from one category to another between the first and second data base year. Mathematically, these probabilities are computed as follows:

$$P_{ijt} = N_{ijt}/N_{it}$$

where:

$N_{ijt}$ = Number of firms moving from category i to category j in the base period (t to t + i)

$N_{it}$ = Number of firms initially in category i at time t

The above probabilities form the key input for the Markov process. They are used in a series of computations that also involve the distribution of the sample firms over the variable or activity being analyzed. The first computation involves multiplying the distribution of sampled firms for the initial data base year by these probabilities. The result is the distribution of the sampled firms for the second data base year. This distribution is then multiplied by the probabilities. A third distribution results. This predicted distribution is again multiplied by the probabilities, resulting in a fourth distribution. The multiplication procedure continues until it results in no change in the distribution of firms over the categories of the variable or activity. This stable distribution and all distributions from the third on are projections of the Markov process. However, only the final distribution is usually of interest because it represents the predicted end result of the changes which occurred between the data base years.[7]

[7]For a more detailed description of the Markov process, see Foltz (2, pp. 15-21).

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